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Three-Tier Approach to Chemical Spill Response

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Major chemical spills create special problems in protection of both public and worker health. The current standard of practice for a major spill requires the evacuation of personnel for a specified distance downwind, using exposure limits and dispersion models to define a toxic corridor's safe and unsafe areas. The implication of this practice is that there is significant health risk inside the toxic corridor and no significant risk beyond the corridor. Because of the high level of uncertainty in both the exposure limits and the dispersion modeling used, these corridors are understandably conservative in an attempt to develop a high degree of confidence that people outside the toxic corridor are not endangered. However, this conservative practice can result in very large, predicted, toxic hazard corridors creating evacuation problems and additional hazards.

Before 1985, the United States Air Force used National Academy of Science (NAS) -- National Research Council (NRC) published emergency public exposure limits for nitrogen dioxide (NO_2) and the hydrazine fuels used in rocket and missile operations. In 1985 and 1989, the NAS–NRC Committee on Toxicology published a new, lower, short-term public exposure guidance level (SPEGL) for NO_2 and the hydrazines used in Titan rockets. This lowering of the exposure limit caused a significant increase in the length of the predicted potential toxic corridor at Vandenberg Air Force Base, extending it well beyond the controlled areas of the base into populated areas, significantly impacting the base's ability to perform higher risk operations such as fueling and launching the rocket. This forced a re-evaluation of the standards and practices used for hazard planning.

Predicting the toxic hazard corridor requires three principal elements: rate of contaminant evaporation, dispersion modeling, and exposure limits. This paper focuses on the exposure limits, the associated health risk, and response actions.

If a chemical release does occur, the information needed by the Base Commander is the degree of risk to human health and safety. Risks can be either immediate or long term and can affect the general population or selected sensitive individuals.

In the case of NO_2, there is much experience with human exposure. In the average population, the risk is considered immediate with a finite threshold for irreversible health damage; however, there is a sensitive subpopulation that may suffer from secondary effects caused by exposures at much lower levels. The SPEGL is set at a level to protect this sensitive subpopulation, but it does not give the Base Commander the risk information needed to evaluate, plan for, and respond to a large chemical spill. The Environmental Protection Agency's (EPA) *Technical Guidance for Hazard Analysis, Emergency Planning for Extremely Hazardous Substances* (December 1987) sets the "Level of Concern" for public emergency exposure at 1/10 of the "Immediately Dangerous to Life and Health" (IDLH) level. EPA has also established an air pollution ceiling goal for NO_2, above which is the "significant harm level" for the public as a whole, including sensitive subpopulations. The Occupational Safety and Health Administration (OSHA), the American Conference of Governmental Industrial Hygienists (ACGIH), and the National Institute for Occupational Safety and Health (NIOSH) have all published occupational exposure limits for short-term, periodic exposures.

The hydrazine family of fuels creates a different problem. Although acute toxicity data are available, these chemicals have been listed as suspected human carcinogens. This identification as suspected carcinogens caused NIOSH to remove the IDLH listing for these chemicals from the NIOSH *Pocket Guide to Chemical Hazards*, Fifth Printing. The Pocket Guide data were not intended to be used for emergency response; however, the Guide had become the standard source for IDLH data from a recognized agency. Therefore, when the IDLH levels for suspected carcinogens were deleted, a void was created in "officially recognized" IDLH values for hydrazines. This makes it difficult for a Base Commander to defend the use of an exposure limit that is not sanctioned by a recognized agency.

In order to provide the Base Commander with better tools to evaluate risk from and respond to failures of these fuel systems, we developed a risk-based approach to toxic hazard prediction and response. The approach identified three risk categories, each with an associated risk and response procedure. Although this approach may not be necessary or practical for small chemical spills, it greatly helps manage both planning and response to large toxic chemical spills.

Table I shows the sources of several published exposure limits for the primary rocket fuels. This information was used to identify existing standards and to help clarify relative risks for different exposure limits. These risks can be divided into three categories: immediately hazardous to life and health,

TABLE I. Exposure Standards and Levels of Concern (L.O.C.)

Standards		Level /Tier		
		1	2	3
Nitrogen Dioxide				
IDLH/1/2 IDLH	50/25 ppm	X	—	—
EPA L.O.C.	5 ppm	—	X	—
EPA significant harm level/ pollution ceiling goal	2 ppm (1 hr avg.) 0.5 ppm (24 hr avg.)	—	—	—
SPEGL/NAS–NRC	1 ppm (1 hour)	—	—	X
ACGIH short-term exposure limit (STEL) (1990)	5 ppm (15 min)			
OSHA STEL	1 ppm (15 min)*			
UDMH (Unsymmetrical dimethylhydrazine)				
IDLH/1/2 IDLH	50/25 ppm	X	—	
EPA L.O.C.	5 ppm	—	X	
SPEGL/NAS–NRC 1989 (cancer)	24 ppm (1 hr)	—	—	
ACGIH time-weighted average (TWA), (1990) [proposed]	0.5 ppm [0.01 ppm]			
OSHA STEL	0.5 ppm (15 min)*			
Hydrazine				
IDLH/1/2 IDLH	80/40 ppm	X	—	
EPA L.O.C.	8 ppm	—	—	
SPEGL/NAS–NRC 1989 (liver)	2 ppm (1 hr)	—	X	
ACGIH TWA (1990) [proposed]	0.1 ppm [0.01 ppm]			
OSHA STEL	0.1 ppm (15 min)*			

*Control to this limit required for planned and repetitive releases.

without regard to long-term cancer risk; potentially hazardous to the general public with effects being reversible or minor; and not significantly hazardous to the general public but posing increased risk to a sensitive subpopulation.

Table II defines the levels of concern categories and reflects the recommended response action for each level of risk. In addition, Table I indicates which exposure limit best fits each level of concern.

This approach requires that the Base Commander accept a certain level of risk for public exposure potential by using exposure hazard data that are available but not "officially" sanctioned; yet, it allows the Commander the flexibility to conduct hazardous operations with a high level of confidence that an effective response can be made to a major chemical release.

Implementation of the three-tier approach required an education campaign for the commanders and operators to get them to understand and accept this new way of planning for disaster. Commanders had to accept the uncertainty of not having a "national standard" to rely upon. Operating instructions, disaster response plans, and computer dispersion models had to be modified to deal with levels of risk and three levels of toxic corridors.

In the final analysis, however, this three-tier approach to managing hazardous chemical spills provides the operational commanders with a risk management tool that permits increased flexibility in establishing policies and in managing hazardous operations with a higher level of confidence.

TABLE II. Description of Levels of Concern

Level 1: Control Access and Evacuate

Immediately dangerous to life and health. Concentrations pose significant risk to exposed personnel.

Recommended Action: Evacuation should be performed unless it creates more risk than seeking shelter or remaining in air-tight shelters.

Level 2: Seek Shelter or Evacuate

Exposure poses some risk to the average individual.

Recommended Action: Seek shelter indoors with outside air intakes closed or evacuate, depending on situation and duration.

Level 3: Sensitive Individuals

Exposure poses no hazard to normal and healthy individuals. Certain sensitive individuals (asthmatics and certain other lung-diseased people) may be at some risk if exposed.

Recommended Action: Similar to Stage 3 air pollution alert, notify the public of release, provide information on potential public exposure and effects, and advise sensitive individuals to avoid strenuous physical activity, remain indoors, and close air intakes. Applies only to N_2O_4/NO_2.